

branching, the absence of a primary tubercle, and the lack of differentiated tissue "may all be urged as more or less primitive features." The absence of a suspensor the author thinks may be compensated for by the haustorial protuberances of the foot. The same foot structure, however, also occurs in certain species of *Lycopodium* which do develop a suspensor. The absence of the suspensor is also counted as a primitive feature.

In discussing the significance of its embryogeny, which is "the simplest among existing pteridophytes," the author states: "While not suggesting that *Tmesipteris* has actually been derived from the *Anthoceros* cycle of affinity, it is clear that the absence from the former of any such organs as root or cotyledon suggests that they approximate in so far as they both represent primitive lines of development. That the simplicity of *Tmesipteris* is not due to reduction is a belief which has greatly been strengthened by the discovery of the rootless and leafless Rhyniaceae. The embryogeny of *Tmesipteris* as described in the present paper makes more clear-cut the theory of the origin of the sporophyte of the Pteridophyta from an *Anthoceros*-like sporangium. . . . The only new feature to be postulated here is the extension in length of the shoot from an apical meristem instead of, as in *Anthoceros*, from an indefinite basal meristem, and the initial cause of the shoot-elongations might be set down as being the adoption of a subterranean mode of life by the gametophyte."—E. A. SPESSARD.

**Life cycles of bacteria.**—LÖHNIS<sup>20</sup> has published a comprehensive survey of the literature dealing with cell forms of bacteria and their significance in relation to the life history of these organisms. The discussion is amply illustrated with over 40 plates containing nearly 400 figures.

The first section of the monograph contains a discussion of cell forms. The author attempts to refute the monomorphistic doctrine of COHN, KOCH, and their followers. It is shown that many bacteria, possibly all, are pleomorphic, and that the varying cell forms often referred to as "involution" or "degeneration" forms are really different stages in the life cycles of bacteria. It is admitted, however, that our knowledge concerning the relationships of these forms is all too meager.

In the second section reproductive organs are discussed. These are gonidia, regenerative bodies, exospores and endospores, arthrospores, and microcysts. Of these the gonidia and regenerative bodies appear to take the most active part in reproduction, while the other organs may represent resting forms. It is claimed that gonidia are common to all bacteria. The fact that they have not always been observed may be due to their small size and high motility. Regenerative bodies may be of any shape, and are produced either by the vegetative cell or the "sympiasm."

<sup>20</sup> LÖHNIS, F., Studies upon the life cycles of the bacteria. Part I. Review of the literature, 1838-1918. Mem. Nat. Acad. Sci. 16: Second memoir. pp. 252. pls. A-S and 1-23. 1921.



The third section of the monograph contains a discussion of this symplastic or amorphous state, in which it is claimed that all bacteria may live and from which new cells may form. The monograph concludes with brief discussions of "conjunction" and of methods of study. While LÖHNIS' discussion of pleomorphism is excellent, it must be admitted that the sections dealing with reproductive organs and with symplasm are not entirely convincing. It is at times difficult to follow his interpretations of the illustrations. At the same time, the monograph is very suggestive of lines of work which ought to be followed in the study of the life cycles of the lower organisms. Such investigations would be well worth while.—J. F. NORTON.

**Mycorrhiza of forest trees.**—The conclusions of McDOUGALL<sup>21</sup> that "the tree is not benefited by association with the fungus, and that the ectotrophic mycorrhizas are not symbiotic associations, but are instances of the parasitism of fungi on the roots of trees," have caused some doubt of the importance ascribed to root fungi by FRANK and other earlier workers. A recent preliminary paper by MELIN,<sup>22</sup> however, indicates that in all probability McDOUGALL was unwarranted in rendering so general a verdict, and while mycorrhizas may be quite unimportant for many American trees, they nevertheless assist in the nutritive processes of certain species, and may be an absolute necessity for some, as recently shown by RAYNER<sup>23</sup> in the case of *Calluna vulgaris*.

In the present investigation MELIN has found that the mycorrhizas of *Pinus silvestris* and *Picea Abies* cause a limited development of rootlets. In the former the dichotomous branching is often modified by the development of nodules as large as peas, composed of many densely crowded short branches. Three mycorrhizal fungi have been isolated from the *Pinus* by this worker, and one from the *Picea*. They have been preliminarily called *Mycelium radialis silvestris* and *M. radialis abietis*. Their systematic position and internal relations are for the present left open. They are aerobic organisms growing more vigorously in an acid substratum, are exceedingly specialized, and develop slowly. No fixation of nitrogen takes place in pure cultures of the fungi, although there is evidence that the mycorrhizas of *Pinus silvestris* fix the nitrogen of the air. Seeds of both these trees germinate without the fungi, and there is no dissemination of the fungi by the seed. The fungi from pure cultures infect sterile seedlings through root hairs, and the young plants then develop more vigorously. At first the hyphae grow principally in the interior of cortical cells, where they form a pseudoparenchyma of the same appearance as in the fungus mantle of the completely developed mycorrhiza. Later the "Hartig tissue" and the fungus mantle are formed.—GEO. D. FULLER.

<sup>21</sup> McDOUGALL, W. B., On the mycorrhizas of forest trees. Amer. Jour. Bot. 1:51-74. pls. 4. fig. 1. 1914.

<sup>22</sup> MELIN, ELIAS, On the mycorrhizas of *Pinus silvestris* L. and *Picea Abies* Karst. A preliminary note. Jour. Ecol. 9:254-257. 1922.

<sup>23</sup> RAYNER, M. C., Obligate symbiosis in *Calluna vulgaris*. Ann. Botany 29:97-153. 1915.